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ABSTRACT

Several experiments were conducted to show that knowledge of the spelling of words is involved in making decisions about how they are pronounced. The experiments used a lexical decision task with only spoken words and nonwords. Subjects in each experiment heard an uninterrupted list of spoken words and nonwords at a rate of about one item every two seconds and made a decision about every item. The major manipulations in the experiments were the phonemic and orthographic relationship between the target item, for which reaction time was measured, and the preceding item on the list. Three kinds of relationships were examined: (1) no relation between the target word and the preceding item, (2) target item related by sound to the item preceding it, and (3) target item related by sound and spelling to the item preceding it. The results indicated that orthographic overlap from the beginning of a word produced facilitation of decisions about spoken words, whereas comparable phonemic overlap did not. In addition, the spelling knowledge responsible for the facilitation came from recognizing an actual word. (FL)

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The influence of spelling on speech perception

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Abstract

In several lexical decision experiments using spoken words, we found facilitation when successive words shared the same spelling; e.g., "nap" was recognized faster after "napkin" than after "teaspoon". Facilitation was not observed when words had the same pronunciation but differed in their spelling; e.g., "record", "wreck". The results suggest that facilitation is based on knowledge available upon word recognition.

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In this paper we make the claim that listeners sometimes spell out words as they hear them. We describe several experiments which show that knowledge of the spelling of words is involved in making decisions about spoken words.

Our experiments used a lexical decision task with only spoken words and nonwords. Subjects in each experiment heard an uninterrupted list of spoken words and nonwords, at a rate of about one item every two seconds. Listeners made a decision about every item, and the time to make a word or nonword decision was measured from the beginning of the item. Our results are based on reaction times (RT's) to certain words, as a function of the preceding item. For example, we compared RT to the word "bar" when it was preceded by "barber" at one point in the list, and RT to the same word when it was preceded by another word, "quarter", at a different point in the list.

The major manipulations in these experiments were the phonemic and orthographic relationship between the target item, for which we measured RT, and the preceding item in the list. There were three kinds of relations that we looked at in our studies. In one case, there was no relation of either kind between the target (second) item and the preceding item; for example, "insect", "spy"; "letter", "mess". This was our Control condition. For other pairs of successive items, the target item was related by sound to the item preceding it. More specifically, the target item occurred as a first syllable of the preceding item; e.g., "spider", "spy". These pairs overlapped in

their phonemic "spellings". In a third case, the target item was related by sound and by spelling to the item preceding it; e.g., "message", "mess". The word "mess" is embedded in "message" both phonemically and orthographically.

Several studies have shown facilitation of a lexical decision due to a preceding related item (Meyer, Schvaneveldt, & Ruddy, 1974; 1975; Fischler, 1977; Hillinger, 1980). The design of our experiments allowed us to look for effects of relatedness along the dimensions of phonemic similarity and orthographic similarity. If both kinds of relatedness can produce facilitation, we should see "spy" being facilitated by "spider", due to phonemic similarity, and "mess" receiving orthographic facilitation from "message", in addition to facilitation due to phonemic similarity.

The first experiment we conducted included just the conditions outlined above. In this study, listeners made only "yes" responses. They pressed a button as soon as possible when they decided that the item they heard was a word. Table 1 below presents the results. (In the tables below, the experimental conditions are labelled by the example items we refer to.)

The results showed only an effect of orthographic similarity on lexical decision times. Hearing and making a lexical decision to "spider" did not speed a decision to "spy", whereas hearing "message" produced significant facilitation of a lexical decision to "mess".

Table 1
Mean RT's (in msec)
Experiment 1

		Control
spider spy	871	834
message mess	779	831

Experiment 2

		Control
spider spy	870	869
message mess	814	847

The results of two more experiments replicated this finding. A second study used the same items, but, as is more usual with lexical decision experiments, had listeners respond "yes" and "no". The results appear in the bottom half of Table 1. With this version of the task, which we have continued to use, we again found an effect of orthographic similarity, but no effect of phonemic overlap. In a third experiment, we made sure to include "catch" trials, like "family" followed by "fam", a nonword. We also devised a new set of items. We again found evidence of orthographically-based facilitation. Table 2 below shows these results.

Table 2
Mean RT's (in msec)
Experiment 3

		Control
laundry lawn	873	895
napkin nap	805	860

To summarize our results thus far: Using spoken words, we have consistently found an effect of orthographic similarity on lexical decision times. Decisions to words were faster when they were preceded by a word that had the same initial spelling pattern. Our materials have received much scrutiny, and as far as we can tell, the same spelling pairs do not have any special semantic, morphological, phonological, or acoustic-phonetic relation between the preceding word and the target not also found for the different spelling items. We are led to conclude then, that the effect we have found is due to spelling similarity, a conclusion that in turn implies that knowledge of spelling is available in the course of making a lexical decision about spoken words. We return to this point later. We might speculate that an orthographically-organized mental lexicon -- like an actual dictionary of written words -- is what allows facilitation of decisions to words related by initial spelling pattern. In contrast, in all our experiments we have not found comparable facilitation due to overlap of initial phonemes. We have not seen evidence of parallel phonemic dictionary, organized by phonemic "spelling". It is, of course, possible that other dimensions of phonological similarity (e.g., rhyme, see Hillinger, 1980) are more salient psycholinguistically.

We were interested in the source of the orthographic facilitation we observed; that is, does orthographic facilitation depend on recognizing an actual word, or can it be produced by a spelling generated for a regular English nonsense word? In a

fourth experiment, we used both words and nonwords as preceding items, and words and nonwords as target items.

This experiment included several conditions. Part of the experiment duplicated the conditions of the experiments already described, in which target words were preceded by words; e.g., "cherry", "chair"; "tapestry", "tap". A second part of the experiment involved nonwords preceded by words. As in the conditions already described, the nonword target was the first syllable of the preceding word. This part of the study included item pairs related by sound, e.g., "precious", "presh" and "faucet", "foss", and item pairs related by sound and spelling, e.g., "princess", "prin" and "vampire", "vam". We needed to be sure that for our listeners, these nonwords would be spelled the way that we intended, so we pretested our items. We chose item pairs that received a correct spelling of the actual word, and an appropriate spelling for the embedded nonword.

The spelling pretest showed that listeners were able to generate spellings for nonwords. The third part of this experiment paired a preceding nonword with a word or nonword target. The target items were the first syllables of the preceding items. For these pairs we had only similarly spelled items. Some examples of word-target pairs are "capple", "cap" and "matever", "mat"; examples with nonword targets are "bishel", "bish" and "glappy", "glap". We remind the reader that these examples are the experimental pairs. RT's to the target items were compared to a Control condition. The results of this fourth experiment are shown in Table 3 below.

Table 3
Mean RT's (in msec)
Experiment 4

		Control
cherry chair	949	945
message mess	885	944
precious presh	1046	1092
princess prin	1027	1137
capple cap	899	953
bishel bish	1150	1104

The top third of Table 3 shows another replication of our basic finding. The middle third of the table shows that this experiment provided a second instance of an influence of spelling on lexical decisions. The orthographic similarity between a word and a following nonword affected decision times. Listeners were quicker to reject a nonword that overlapped in spelling with a preceding word. Thus, these two parts of this experiment showed a facilitation of lexical decisions when spelling overlapped with a preceding word.

The third part of the experiment considered whether a spelling generated for a nonword could facilitate a subsequent lexical decision. The bottom third of Table 3 shows the results from the two conditions of this part of the study. These results

looked puzzling to us since in one case, a nonword facilitated a subsequent word decision, but, in the other case, a nonword did not produce facilitation of the next nonword decision. We know from the other two parts of this experiment that decisions about both words and nonwords could be facilitated by similar spelling.

In the case of the nonwords that contained a word as a first syllable, there was a possible source for facilitation not due to similar spelling. Taft and Forster (1976) have shown that written nonwords that begin with words appear to contact the embedded word during attempted access. We suspected that our embedded word targets might be related in such a way to their preceding nonword items. Moreover, for a good number of items, the nonword was formed from a word and a derivational morpheme, e.g., "ringdom" from "ring" and "-dom", resulting in a very "word-like" item, related to the target word. We ran an additional study to determine whether these nonwords made listeners "think of" the target items.

We asked a group of listeners to give the first word they thought of when they heard a spoken nonword. Examples of typical responses are: "cap" and "capful" to "capple", and "matter", "matador", and "cadaver" to "mataver". For most of the items, the nonword "evoked" the target word or a word semantically related to the target. These pairs showed facilitation of lexical decisions to the target relative to the Control condition. For a small number of items, for example "mataver", the nonword was not related to the target word, and

these words did not show any facilitation. Remember that for our pairs with preceding words, the word was not related to the target except by spelling. We propose that the overall facilitation we found for this condition was due to the nonwords' "evocative" relation to the target, and not to shared initial spelling. We suggest, then, that facilitation due to orthographic similarity depends on having a spelling from recognizing an actual word. That is, the spelling knowledge that is involved in producing the effect becomes available upon recognizing a word.

Our overall conclusions from our series of studies are 1) that orthographic overlap from the beginning of a word produces facilitation of decisions about spoken words, whereas comparable phonemic overlap does not; and 2) that the spelling knowledge responsible for the facilitation comes from recognizing an actual word. Thus, we are claiming that knowledge of spelling available from recognizing a spoken word is involved in a lexical decision task. For instance, in the course of deciding that "napkin" is a word, knowledge of its spelling is made available, knowledge that can affect the next lexical decision.

Why is spelling information accessed during this task? One possibility is that knowledge of spelling is available automatically -- that we can't help but activate all our knowledge associated with words. After all, that's what word recognition is for, to make available our knowledge about words to other processes. A second possibility is that available

spelling knowledge is used as part of the listener's strategy for the task, which is to make deliberate judgements about words. Spelling -- more generally, knowledge about written words -- represents a very accessible and explicit form of knowledge about words, at least for our "literate" college student subjects. Other investigators have found evidence that an orthographic representation may be used by listeners in making decisions about spoken words (Seidenberg & Tanenhaus, 1979), and their constituent units (Morais, Cary, Alegria, & Bertelson, 1979; Rudnicky, 1980; Warren, 1971). Questions about the role of spelling in speech perception are part of the more general issue of the kinds of representations that become available in the course of recognizing words, and their role in processing (e.g., Foss & Blank, 1980).

Similar to our finding that an orthographic representation is available for spoken words during a lexical decision are the demonstrations of the availability of a phonological code for written words (e.g., Meyer, Schvaneveldt, & Ruddy, 1974). In our case, we cannot conclude that the orthographic code is used in the process of lexical access itself. That is, we dare not suggest that listeners convert sounds to letters <u>in order to</u> recognize words. A theoretical caution to be drawn from our research concerns conclusions about the roles of various levels of representation in lexical processing, and the locus of effects of codes in another modality (see Hillinger, 1980, and Bauer & Stanovich, 1980, regarding the role of a phonological code in recognizing written words).

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